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Contractor :

METZ University, Faculty of Sciences
Laboratory of Physics and Mechanics of Materials, METZ, FRANCE

Research project :

Experimental Investigation of Adiabatic Shear Banding at Different Impact Velocities

Principal Investigator : J.R. KLEPACZKO

4 rd Interim REPORT
from : Nov. 19,1991 to : May 18,1992

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REPORT DOCUMENTATION PAGE

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Title of proposal : **Experimental Investigation of Adiabatic Shear Banding at Different Impact Velocities**

Report Number : 04/92
Period covered : Nov. 19/91 to May18/92

Name of Institution : Metz University, Faculty of Sciences,
Laboratory of Physics and Mechanics of Materials, Metz, France

Principal Investigator : J.R. KLEPACZKO

ABSTRACT

During the interim period, Nov. 19, 1991 to May 18,1992, the operational stage of the new experimental technique of fast shearing has been achieved. The technique has been tested, as an preliminary stage, on annealed low alloyed mild steel (0.17 % C, 0.58 % Mn). It was attempted to find the conditions for critical shearing as a function of impact velocity. A scanning electron micrographs of the fracture surfaces have been taken.

However, still the open question remains which kind of steel should be tested as a final solution. The Principal Investigatior had asked both places, that is MLT - WATERTOWN and ETCA - PARIS - ARCUEIL, about two months ago, and so far suggestions have not came. Finally, one post-doc has been hired to study rate effets in Mode II of fracture.

1. The current status of the projet

Within the framework of the research contract entitled "Experimental Investigation of Adiabatic Shear Banding at Different Impact Velocities" ; contract number : DAJA 45-90-C-0052 ; the following activities should be reported :

i. The new experimental technique is operational, including the air gun and measuring systems, that is optical displacement gage and elastic wave propagation in a measuring tube ;

ii. Preliminary series of tests have been performed on low - alloy steel (0.17 % C, 0.58 % Mn) in the annealed state ;

iii. Preliminary analyses of behavior of this steel has been completed, that is rate effects on the lower and upper yields limits, up to strain rate ~ $10^5\ s^{-1}$;

iv. The Principal Investigatior waits for a final decision which material should be tested.

2. Further details on current activities

Since experimental technique is now operational, preliminary series of tests has been performed on low alloy steel (0.17 % C, 0.58 % Mn) in annealed state ; French Standard XC18. This steel served as an calibration material, because of earlier studies on its thermal and mechanical properties at different temperatures and strain rates (a low strain rate region). Those preliminary tests have been performed at impact velocities from 30m/s to 100 m/s, which are adequate to the nominal shear strain rates for the Double Shear specimen (DS - specimen) from $\dot{\gamma} = 1.5 * 10^4\ s^{-1}$ to $\dot{\gamma} = 5 * 10^4\ s^{-1}$. Analyses of oscillograms permitted for determination of the upper and lower yields stresses for this steel as a function of the nominal strain rate, those results are shown in Fig. 1 and Fig. 2 attached to this interim report. In Fig. 1 are shown the mean values of the upper yield point as a function of log $\dot{\gamma}$. Within the region of small strain rates the mean values were determined from the tensile tests, $10^{-4}\ s^{-1} <= \dot{\gamma} <= 1.0\ s^{-1}$.

At higher strain rates all points were obtained after an individual test (one test one point). At strain rates $10^2\ s^{-1} <= \dot{\gamma} <= 10^3\ s^{-1}$ a dynamic closed-loop testing machine was used along with DS specimens. Finally, at the highest strain rates the new experimental technique was employed. As expected the upper yield point increases very quickly with strain rate. In Fig. 2 are shown similar results but for the lower yield stress, denoted as stars - JRK. For comparison are also shown experimental results of Klopp and Cliffon* for 99.98 % Fe obtained with pressure - shear experiments.

Although it is possible to determine with this new technique the whole shear stress vs. shear strains curve, a more exact analysis of the critical shear strains is in progress. It is hoped that a new series of tests on a steel suggested by MTL-Watertown or ETCA - Paris will provide more experimental data on both, flow stresses and critical strains.

* R. W. Klopp and R. J. *Cliffon*, *Pressure-Shear* Impact and the Dynamic Viscoplastic Response of Metals, Proc. Workshop on Inelastic Deformation and Failure. Modes, Northwestern University, (Nov. 18-21, 1984).

Fig.1 Upper yield stress as a function of $\log \dot{\gamma}$; low alloy steel XC18 (0.17 %C, 0.58 %Mn).

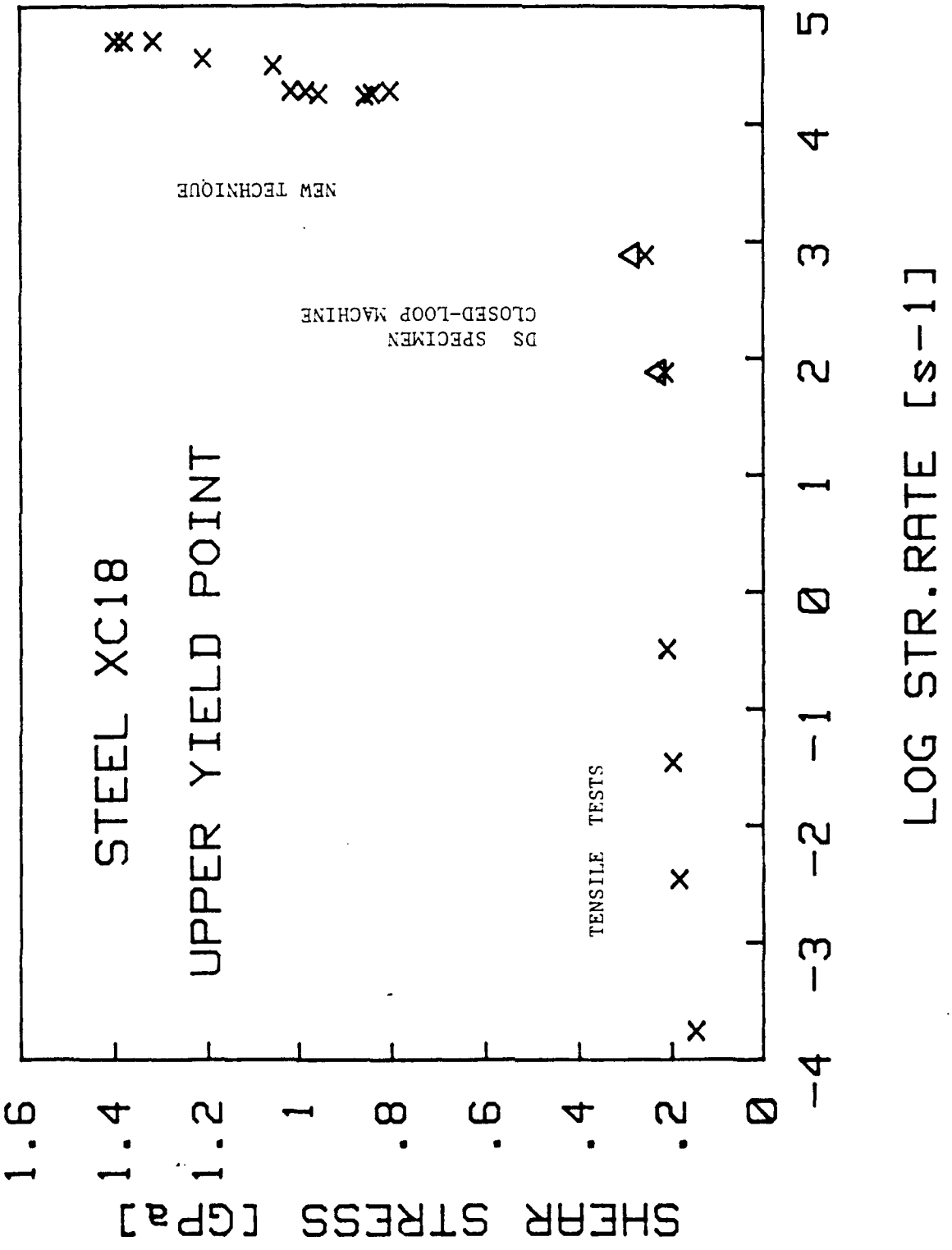

Fig.2 Lower yield stress as a function of log $\dot{\gamma}$;
* XC18 steel (0.17 %C ; 0.58 %Mn) ;
o ▽ x - data of Klopp and Clifton for 99.98 %Fe (for reference see text).